

Bridging Machine Learning and Game Theory: Shapley Value approximation in Cooperative Games

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joint work with

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*Dedicated to the memory of our colleague and friend Yuval Hadas.
We will remember Yuval as an enthusiastic researcher and a very kind person,
a pleasure to work with and spend free time with*

Open Challenge contribution

Abstract

Since the very beginning, there has been a fruitful exchange between Machine Learning and Optimization. While Machine Learning exploits optimization models and algorithms, it simultaneously poses problems that often represent optimization challenges. Moreover, Machine Learning can be fruitfully combined with optimization algorithms to improve their performances. Here, the optimization model known as Cooperative Game Theory is considered, which studies strategic interactions among agents and has links to disciplines such as Economics, Engineering, Computer Science, Robotics, Political and Social Sciences, Biology, Medicine, etc. The focus is on preliminary results and open issues in the approximate computation via supervised learning of the Shapley Value - a well-established concept in Cooperative Games - which serves as a metric for assessing the relative significance of players. It has found many applications, among which gauging the importance of individual nodes or arcs within complex networks (e.g., logistic, social, telecommunication networks), in such a way to design them optimally and/or improve existing ones. However, typically the computation of the Shapley Value of nodes/arcs in extensive networks is computationally expensive. This talk addresses the challenge

of approximating via Machine Learning the Shapley Value in Cooperative Games defined on large networks, which are parameterized by quantities of interest (e.g., traffic demand in a transportation network). The smoothness properties of the Shapley Value with respect to network parameters are investigated and exploited to develop supervised learning techniques for its approximate computation. First, numerical results on a test-bed are presented, then open problems, research directions, and challenges in the interplay between Machine Learning and Cooperative Games are discussed.

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